REMARKS/ARGUMENTS

Applicants would like to thank Examiner Miggins for the helpful and courteous discussion he had with Applicants' U.S. representative on March 9, 2006. At that time, Applicants' U.S. representative noted that the combination of the cited references (Borst, U.S. 2,726,339 and Kanjiro, JP 06-294897) does not teach or suggest the claimed radiation shielding material because neither reference describes a radiation shielding material that has a content of calcium hydroxide in a range of 15% to 60% by mass after hardening through hydration reaction. The following expands upon that discussion.

Borst describes a concrete radiation shielding medium for providing protection from radioactive substances. The concrete may contain various levels of metallic materials including iron. However, as the Examiner notes on page 3 of the Office Action, Borst does not teach or suggest calcium hydroxide in a range of 15 to 60% by mass after hardening through hydration reaction.

Kanjiro (a machine translation is attached) describes an aggregate for use in producing a cementstructure for radioactive waste. Kanjiro describes the need for the cement to have a high pH to minimize corrosion of metal in the radioactive waste structure. One method of achieving the high pH is to maintain the calcium hydroxide level at about 2% in the cement. Kanjiro meets this need by using cement clinker as an aggregate. Use of the aggregate minimizes the dissolution rates of calcium hydroxide in the cement allowing for residual calcium hydroxide to be present in the cement over longer periods of time (see paragraphs [0008] to [0013] in Kanjiro). Figure 1 in Kanjiro is a plot of the residual calcium hydroxide concentration of various cement formulations as a function of time.

Applicants note that a normal cement composition will have an initial calcium hydroxide concentration in the 10 to 20% range when the composition is initially mixed with water. However, as the cement cures and hardens the calcium hydroxide concentration drops

to below 5% as the calcium hydroxide reacts with other components in the cement formulation during the curing process. This can be seen in Figure 1 of Kanjiro. Accordingly, the cement formulation described in Kanjiro does not contain calcium hydroxide in a range of 15 to 60% by mass after hardening through hydration reaction.

Because neither Borst nor Kanjiro teach or suggest a radiation shielding material with a content of calcium hydroxide in a range of 15% to 60% by mass after hardening through hydration reaction, the claimed material would not have been obvious over the combination of Borst and Kanjiro. Therefore, Applicants respectfully request that the Examiner withdraw the rejection.

As noted above, the goal in Kanjiro was to maintain a high pH in the cured cement over a long period of time to minimize corrosion of metal in the cement structure. The goal was achieved by utilizing aggregates in the cement formulation which allowed for a residual calcium hydroxide concentration of about 2% in the cement structure.

In contrast, one of the goals of the claimed invention is to improve the radiation shielding ability of the radiation shielding material. This improvement leads to a reduction in the thickness of the shielding structure which in turn leads to smaller and lighter structures (page 12 of the specification).

Applicants have found that the claimed radiation shielding material gives superior properties in regard to radiation shielding particularly with regard to neutron-shielding performance. These results are illustrated in Fig. 1 which plots the relative dose rate as a function of the content of calcium hydroxide in the finished structure (lower does rates mean better shielding). Fig. 1 illustrates the dramatic decrease in dose rate (increase in radiation shielding) when the radiation shield material contains 15% to 60% by mass of calcium hydroxide. The dose rate drops by a factor of 3 when the calcium hydroxide content is increased from 10% to 15% by mass. Applicants note that neither cited reference teaches or

suggests the role of calcium hydroxide in radiation shielding. Accordingly, the claimed radiation shielding material would not have been obvious over the combination of Borst and Kanjiro, and therefore, Applicants respectfully request that the Examiner withdraw the rejection under 35 U.S.C. § 103(a).

In light of the remarks contained herein, Applicants respectfully submit that the present application is now in condition for allowance. Favorable reconsideration is respectfully requested.

Respectfully submitted,

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* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the aggregate used for the processing structures (for example, a filler, solid-ized material, a structure, etc.) of radioactive waste.
[0002]
[Background of the Invention] The nuclear peaceful use in our country goes through 30 odd years, and, also globally, attracts attention by the end of today. And nuclear electric power generation occurs as one of the nuclear peaceful use, and the big role as a power source of supply with stable nuclear electric power generation is demonstrated by the end of today. Radioactive waste is produced from various kinds of nuclear installations. And processing of this radioactive waste Cement system solid-ized material and radioactive waste are put in in processing containers, such as a drum. Carry out kneading solidification of the **, or Put in radioactive waste in processing containers, such as a drum, and fill up the clearance with cement system solid-ized material, and it is solidified. And after transporting to the facility built with concrete etc. after covering and arranging in a facility, stabilizing treatment of the perimeter of these solidification objects is carried out with fillers, such as cement mortar and concrete, and it is kept.
[0003] By the way, in order to attain defanging of the processing solidification object which the long TRU nuclear species of a half-life like Np, Pu, and Am also have in radioactive waste, therefore was put into radioactive waste, also after a solidification object and a structure collapse hundreds of years after, there will be the need of building the environment where the long TRU nuclear species of a half-life cannot shift easily to the bottom of a living environment, about millions years.
[0004]
[Description of the Invention] The purpose of this invention is offering the technique radioactive waste's being safely processed over a long period of time. The purpose of above-mentioned this invention is the aggregate used for the processing structure of radioactive waste, and is attained by the aggregate used for the processing structure of the radioactive waste characterized by coming to consist of this aggregate cement clinker.
[0005] What is necessary is for the processing structure of the radioactive waste in this invention to be the cement mortar object and concrete object which are used for processing of radioactive waste, to be the cement mortar with which the inside of the processing container of radioactive waste or the perimeter of a container is filled up, or to be the concrete structure of the treatment facility of radioactive waste, for radioactive waste to be processed, and for radioactive waste to be used for the location where storage, disposal, etc. are carried out over a long period of time, and to just be constituted using the aggregate or cement.
[0006] and there are a fine aggregate and coarse aggregate in the aggregate, and only the fine aggregate may consist of cement clinker, and only coarse aggregate consists of cement clinker -- having -- **** -- and a fine aggregate and coarse aggregate -- any aggregate may consist of cement clinker. Here, although a fine aggregate has the magnitude of about 5mm or less and coarse aggregate has the

magnitude of about 5mm or more, even if it has separated from some from this definition, it should just demonstrate the function as the aggregate.
[0007] Hereafter, this invention is explained to a detail. The weathering of concrete must be taken into consideration, if it takes into consideration that a storage time crosses also in hundreds of even if the storage facility of a radioactive waste disposal object is built with concrete. And temporarily, if safety is taken into consideration, also after a facility collapses, it must be designed so that the long radionuclide of a half-life cannot shift easily, so that the radioactive waste shut up, especially the long radionuclide of a half-life cannot shift easily out of a facility, also after weathering starts.
[0008] By the way, it has turned out that pH is an important factor at reservation of the long-term safety of storage of a radioactive waste disposal object. For example, in the condition of high pH like about ten (12 or more [Preferably]) or more, since the corrosion of a metal component becomes slow, therefore damage on the reinforced concrete structure which constitutes a facility becomes so slow and pH is rich in endurance, it is considered that the long-term safety of storage increases. And the solubility to the water solution of radionuclide, especially long lasting radionuclide becomes low, and even if it breaks out that the processing container and facility of radioactive waste will weather hundreds of years after, it is considered to be prevented effectively that radionuclide, especially long lasting radionuclide are oozed and spread in an underground water. Moreover, since the activity of a microorganism is also suppressed, it is thought that long term stability, such as a radioactive waste disposal and a disposal facility, increases so much.
[0009] therefore, a radioactive waste disposal facility and a processing object -- high -- to consist of pH materials is desired strongly. By the way, the cement used for processing of radioactive waste so far 3 CaO-SiO2, 2 CaO-SiO2, 3 CaO-aluminum 2O3, 4 CaO-aluminum 2O3, and Fe 2O3 It has the thing of the said presentation. therefore -- if it reacts with water -- calcium (OH)2 since it generates -- the cement (concrete) structure -- high -- it is thought that it is a pH material and it is thought that the above-mentioned request is filled.
[0010] However, calcium2 which determines pH of cement (OH) When retentivity was investigated, this was the result of being shown in drawing 1 and drawing 2 . The commercial Soxhlet extraction testing device is used, the constituent of cement is put into the extract section, water is put into the flask section, it heats with a mantle heater, a decoction is taken out to predetermined time, and drawing 1 is calcium (OH)2 of a decoction. It is the graph with which it measured and calcium (OH)2 investigated in the sample which remains, and drawing 2 is the graph which investigated calcium/Si in a sample.
[0011] According to this, also although a reaction with water generates the calcium hydroxide in cement paste, it is guessed that this is lost gradually comparatively quickly. For example, if invasion and diffusion of an underground water are considered, it will be predicted that the rate which a calcium hydroxide is lost and goes from the cement (concrete) structure which constitutes a radioactive waste disposal facility and a processing object is remarkable. When to be high pH is demanded over hundreds of years - millions of years, it becomes impossible and to be fully satisfied with the cement (concrete) structure like the former.
[0012] By the way, the invention-in-this-application person investigated similarly on the occasion of the research which uses the above-mentioned Soxhlet extraction testing device about the aggregate which ground and obtained not only cement but cement clinker in predetermined magnitude. This result was fortunate. That is, it is calcium (OH)2 also about the case of the aggregate made from cement clinker. According to [although the result of which remains was shown in drawing 1 and the result of calcium/Si in a sample was shown in drawing 2] these, it is the aggregate made from cement clinker to calcium (OH)2. The rate which carries out dissolution disappearance and which is generated rather than the rate which goes is higher, and it is survival (OH) calcium 2. The result with increasing concentration is shown. And the amount of dissolution disappearance of calcium is also known by that it is far small compared with the case of cement.
[0013] In addition, this phenomenon is considered based on the following. The aggregate made from cement clinker which has desired magnitude reacts with water in the front face, and is calcium (OH)2. It generates. This generated calcium2 (OH) It is in the condition of having deposited on the aggregate front

face made from cement clinker. And calcium2 which deposited (OH) Even if it dissolves in the underground water etc., it is calcium (OH)2. It is gradually supplied from the interior of the aggregate made from cement clinker, and is survival (OH) calcium 2 as a result. It is thought that concentration increases.
[0014] Moreover, there is reinforcement of enough of the cement mortar constituted using the aggregate made from cement clinker or concrete like the case of the cement mortar and concrete which were constituted using the aggregates, such as usual ballast, and the aggregate made from cement clinker can fully be used as the aggregate of the processing structure of radioactive waste. This invention was attained based on such knowledge. That is, when using cement clinker as the aggregate of the cement (concrete) structure which constitutes a radioactive waste disposal facility and a processing object, the way of thinking whether the cement (concrete) structure could be held to the thing of high pH over a long period of time was obtained, and this invention was attained.
[0015] The cement clinker used by this invention dries and prepares the limestone which is the main raw material, clay, silica, etc., pulverizes them, and is obtained by burning this in the half-melting condition at the temperature of about 1450 degrees C with a temporary-quenching furnace and kiln at a pre-heater, after heating at about 850 degrees C, and being fastened. And the coarse aggregate or the fine aggregate made from cement clinker is obtained by grinding this in desired magnitude.
[0016] thus, the presentation of the obtained aggregate -- for example, 3 CaO-SiO2 About 28 wt(s)% and 2 CaO-SiO2 About 56 wt(s)% and 3 CaO-aluminum 2O3 About 2 wt(s)%, 4 CaO-aluminum 2O3, and Fe 2O3 About 8 wt(s)%, and other MgO, SO3, Na2 O, K2 O and TiO(s)2 etc. -- little ** rare ******. In addition, it is not restricted to the thing of this presentation.
[0017] Hereafter, an example explains this invention concretely.
[0018]
[Example]
[Example 1] 3 CaO-SiO2 About 28 wt(s)% and 2 CaO-SiO2 About 56 wt(s)%, 3 CaO-aluminum 2O3 About 2 wt(s)%, 4 CaO-aluminum 2O3, and Fe 2O3 About 8 wt(s)%, in addition, MgO and SO3 of a minute amount etc. -- the low-fever mold cement clinker contained was ground in magnitude of 5mm or less, and the aggregate used for the processing structure of the radioactive waste which it comes to consist of cement clinker was produced.
[0019] And 3 CaO-SiO2 About 28 wt(s)% and 2 CaO-SiO2 About 56 wt(s)%, 3 CaO-aluminum 2O3 4 CaO-aluminum 2O3 and Fe 2O3 about 2 wt(s)% About 8 wt(s)%, in addition, MgO and SO3 of a minute amount etc. -- since cement 2000g contained, the 2000g of the above-mentioned aggregates, and 900g of water were mixed, six 4cmx4cmx16cm mortar specimens were produced and flexural strength and compressive strength were investigated, the result is shown in the following table -1.
[0020]
Table -1 Flexural strength (kg/cm2) Compressive strength (kg/cm2) Seven days after 73 329 28 days after 103 752 -- the physical engine performance which needs for the purpose the solid-ized material of the radioactive waste constituted considering cement clinker as the aggregate, the filler around a solidification object, or a construction object according to this -- an owner -- it turns out that it is a thing the bottom.
[0021] Moreover, it turns out that the storage disposal of the radioactive waste can be carried out over a long period of time at insurance by the ability of the solid-ized material of the radioactive waste which consisted of aforementioned drawing 1 and drawing 2 considering cement clinker as the aggregate, the filler around a solidification object, or a construction object observing [therefore] that the environment of high pH is held over a long period of time.
[0022]
[Effect] According to this invention, the cement (concrete) structure can be held under the high pH environment over a long period of time, prevention of exudation of radioactive waste can be further aimed at now, and the endurance of the cement (concrete) structure is also high, and the features that the long-term safety of a radioactive waste disposal is high are done so.

[Translation done.]

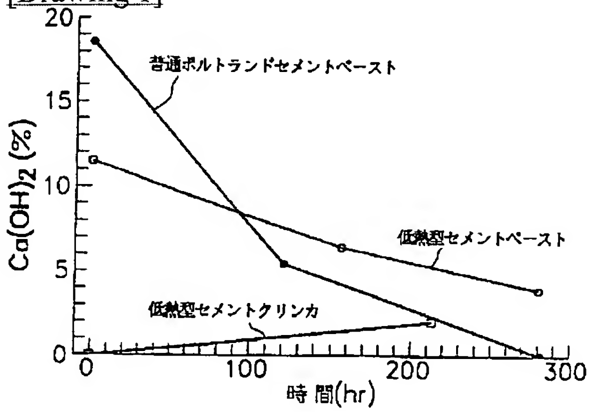
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] calcium2 in a sample (OH) It is the graph which shows the amount of survival.
[Drawing 2] It is the graph which shows calcium/Si in a sample.

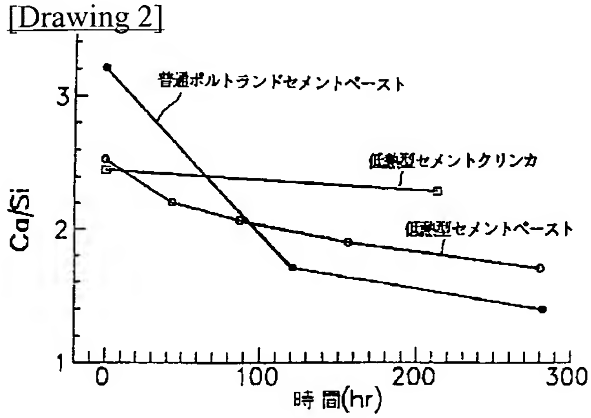
[Translation done.]

DRAWINGS

[Drawing 1]



[Drawing 2]



[Translation done.]